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Manual's End*

" He bringeth the wind out of his treasuries."

The most fundamental, and perhaps the most fascinating, meteorological study is the study of the wind, and that may be the reason why the first part of the " Manual of Meteorology " to be issued was " The Relation of the Wind to the Distribution of Barometric Pressure," and with " Pressure and Wind " the Manual is now " ended " to use the author's own term which is, as usual, more accurate and satisfying than the common " completed." This volume, written with the assistance of Miss Austin, is, in fact, a revised edition of the original Part IV with two further chapters at the beginning, much of them on the meteorological " fringe," and two at the end summarising the hypotheses and realities and the " prospectivities " now within our ken.

The wind bloweth where it listeth and we cannot change its will—but what is the character of its blowing? whence does it come? whither does it go? and what is its relation to pressure? are questions to which we may find answers, not final, but good answers, in this book.

The plain man will find the first two chapters difficult in their

**Manual of Meteorology. Vol. IV. Meteorological Calculus: Pressure and Wind:* by Sir Napier Shaw, LL.D., Sc.D., F.R.S., with the assistance of Elaine Austin, M A. 8vo. 10½ × 7¼ in. pp. xx + 359 + xii, *Illus.* Cambridge University Press, 1931, 30s. net.

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technical parts—the meteorologist will find the plain statements in them whipping him out of his orthodoxical ease. The author is indeed an artist—or a wizard. In Chapter I, although the reader may feel inclined to grumble at first, he is drawn on in spite of himself from Newton's and other laws of motion through the law of dynamical similarity, Maskelyne-and-Devant-ish in the tricks it performs, to the Tay Bridge disaster—responsible for more things than the tragedies of Hatter's Castle, among them (the things, not the tragedies) being the pressure tube anemometer; and with the ribbons woven by this instrument—surely more fascinating than any in the bunch which Johnny promised long ago to buy—the chapter closes.

Back from romance, Chapter II, calls the reader to consider the equations of motion of a parcel of air—eventually in a free atmosphere on a rotating earth—equations mainly non-integrable but still fundamental; and then the author, after inserting a "Skippers' Guide" for very learned skippers, glides back to Halley and the Trade winds, to Helmholtz and Atmospheric Billows, to Ekman and his spiral, turning the sea from the wind as a mermaid might (how enthusiastically I greeted her in *Nature* in 1908, and how severely I was rebuked for putting my trust in Ekman's theory and Nansen's drift, and for "pushing the theory off the solid ground of nature"). The chapter is not ended, for later on the reader will need some cheques on Sol and Co.; and eddy-viscosity, with which we English proudly name the name of Taylor, is also "motion of parcels of air" and has its special equations and its variable coefficients. A short reference to Gião's effort to solve the mathematical problem by an initial elimination of the main difficulties leads appropriately to a review of the contribution of mathematical analysis to dynamical meteorology—in this there appears to be a need for "clarifying the situation"—some of the objections which the author raises to the use of meteorological theory (*e.g.*, the absence of real discontinuities of temperature and wind) apply if there is only micro-mathematics, but do they apply if there is macro-mathematics—and does not the geostrophic wind prove the applicability of macro-mathematics to the atmosphere? A remark on p. 77, "the assumption that the motion of the air is horizontal may lead to serious misconceptions," is related to the history of R.101—it is surely by now an assumption which no meteorologist worthy of the name would consciously make except in conditions in which he knew there was no practical possibility of vertical motion. The chapter ends with a simple exposition of the gradient, geostrophic and cyclostrophic winds and tables for their computation.

In Chapter III, the facts of wind near the surface—at "the foot of the structure"—are related to the horizontal pressure gradient. Reference is made to notable exceptions to the rule

that the wind at 2,000 feet agrees with the theoretical value derived from the pressure gradient—the investigation of such exceptions will be more profitable to meteorologists than the accumulation of 999,999 values which obey the rules—and, perhaps, it would bring more joy in the presence of their angels.

In the section devoted to winds over the sea, the reader feels that he is floundering about with unsatisfactory estimates—made at the wrong times—for comparison with gradients estimated from insufficient data—and in fact the author is conscious of and apologises for this inadequacy, " but the importance of the subject is itself the excuse for making what use is possible of the material that is at hand in the hope that more may be forthcoming." The records from the anemometer on the Bell Rock lighthouse may go some way towards filling the gap, but meteorological ships—with no outside duties and with real meteorologists—observing according to a well-planned scientific scheme, with instruments designed for the purpose, would add more in a few weeks to our knowledge of the relation between wind and pressure over the sea than the above-mentioned number of estimates by observers whose main work and interest is in other things.

Chapter IV treats of turbulence near the surface, and the effect of this on the variation of wind with height is discussed at some length. In connexion with this chapter it is worth repeating that the wind near the surface is not strictly a gradient wind at all; the pressure gradient at the surface and the force of the earth's rotation—the mass forces—do not directly affect in measurable degree the surface wind. This is effectively determined by the balance between the surface friction and the tangential stress due to the transfer of momentum from above. (The momentum available for transfer is determined by the pressure gradient [or determines the pressure gradient] in the layers where turbulence is small). This important fact was stated explicitly by Whipple in 1920; it, and the corresponding fact (or assumption) that the friction at the surface acts in the line of motion, could with advantage be emphasised in the development of this chapter. None the less, the detailed account here given of the theoretical development and the table of values of the eddy-coefficients will save many a meteorologist hours of searching in the haystacks of scientific periodicals for the formulæ or value which he wants.

Chapter V.—Gustiness and Cloud Sheets.—Why this mating of the unstable and the stable? Because, reader, that is the way to stimulate your curiosity, and you will be able to satisfy it with the facts of the anemometer records and the wedding ring of eddy-viscosity and some charming pictures of the lady and her ring taken in France in August, 1918, a week after Rawlinson's confident and inspiring " Thank you, that is

exactly what I wanted to know "—knowledge made possible only by upper-air temperatures read on the aeroplanes on which the photographs were taken for their purely scientific interest; the temperatures are forgotten, the photographs are of the stuff of eternity.

Chapter VI describes the facts of the variation of wind with height up to the stratosphere and even in the stratosphere—about the latter we know far too little, practically nothing at all for those occasions when the troposphere is moving rapidly. The comparative quiescence of the stratosphere is, probably, merely apparent; one conclusion is certain, viz., with a relatively quiet troposphere and stratosphere *ballons-sondes* may sometimes be observed with a theodolite up to heights of 20 Km. or more, and the winds in the stratosphere on such occasions are similar in magnitude to those in the troposphere.

In Chapter VII the relation between the variation of wind with height and the distribution of temperature is treated theoretically and illustrated by examples. One of the most interesting examples comes actually in the next chapter. It is the case of the drift of the Zeppelins on October 19th, 1917, when a west-east gradient of temperature was associated with an unusual increase in the northerly component of the wind at heights above 12,000 feet. In connexion with the variation of gradient wind with height, there is an interesting result, not actually mentioned in the Manual, but attractive for its simplicity; it is this: If T and t are temperatures and P and p pressures at the surface and at height Z respectively, and ϕ and ψ are the angles between the isotherms and the surface and upper isobars respectively, then the ratio of the upper geostrophic wind at height Z to the surface geostrophic wind is simply :—

$$t \operatorname{cosec} \psi / \; T \operatorname{cosec} \phi$$

and ϕ and ψ are related by the approximate equation $\sin(\phi-\psi)/\sin\psi = y\,(P-p)/xT$ where y and x are the distances between successive isobars and isotherms.

Chapter VIII is concerned with stream lines of flow and includes examples of Bjerknes' work in this field, and a note of the connexion of these lines with the art of gliding. In this chapter, too, the tephigram is introduced as an aid in tracing the expenditure of energy in the atmosphere—the spending of the money obtained by cashing cheques on Sol and Co. The author's suggestion on p. 221 for the use of observations with pilot balloons in the study of wave-motion by a comparison with the patterns of Bjerknes' diagrams is very attractive.

Chapter IX—Curved Isobars—takes the reader back to the combination of hard mathematics and romance. After a short discussion of the case of a cap of air covering the polar regions and revolving like a solid about the polar axis, the author proceeds to the fascinating subject of secondaries. The simple idea of a secondary as a revolving mass of air moving forward as it

revolves, in the same way as a penny would on the map if it rolled along an isobar, is shown to require modification owing to the effect of the earth's rotation. In consequence of this effect, the centre of the isobars is moved a distance $\tau/(1 + c \operatorname{cosec} \phi)$ from the centre of the "penny," where $r\zeta$ is the rate of travel of the secondary, ζ and ω the angular velocity of the penny and the earth, ϕ the latitude and c is $\zeta/2\omega$; and a further result of interest is that the gradient wind computed from curved isobars is correct, not for the point at which the gradient is taken, but for a point at a distance $cr/(c + \sin\phi)$ to the left of the wind. A natural consequence is that the isobaric centre is not the place of calm.

If the reader thinks he is now done with revolutions Chapter X will disillusion him. Here he will find theoretical discussion of revolving fluid illustrated by selected examples from the atmosphere itself and the records of anemometers and microbarographs which have passed through revolving masses of air. After this he may be surprised (or relieved) to learn the author's conclusion that the study of trajectories of air is of more importance for meteorological practice than the dynamics of revolving fluid. But there it is, at the beginning of Chapter XI, which is consequently devoted mainly to fronts etcetera—that "etcetera" on p. 287 startled me—was it only the abbreviation "etc." which was mildly corrigible long ago? But the account which the author gives of the development of the "fronts etcetera" on pp. 285-91 is excellent. It is, except for a reference to "this tachistocratic* age," written in language which any well-educated person can understand, and includes a number of vivid mental pictures of the various processes involved in the partially idealized development; here is one: "The cold front is the dominant element of the partnership; it invades the warm front from the north and turning eastward continues its invasion until it has reached and overlapped the eastern portion of the polar front with the easterly wind north of it (somewhat diverted from its normal direction) and thereby isolates the portion of the equatorial air nearest the centre of the cyclone. It thus secures the 'occlusion' of the cyclone. Access of equatorial air along the surface being denied, the cyclone perishes." This eleventh chapter is almost a book in itself—the reader is led from Margules, through Lempfert and Corless, Bjerknes, Van Ryd and the Russians and Japanese back to tradition, and to the cyclone as the "primary expression of atmospheric energy," while the anticyclone is rejected from "the position of prominence which it used to occupy in the dynamics of the atmosphere." All this is naturally mainly a repetition of considerations explicit or implicit in earlier pages of the Manual, but their collection and examination are necessary to round off the picture.

*"ruled by the speediest" E.G.

The last chapter, " Retrospective and Prospective," is meditational. It contains a brief general survey of the whole work and a suggested synthesis of the general circulation, clear and lucid in the " hypothesis " on page 327, but obscure in the " reality " on p. 326, which calls from the recesses of memory Theseus' generous words: " The best in this kind are but shadows."

When I think of this volume as a whole, the impression left on my mind is not of an ordered logical development of a theory of atmospheric motion—such a development might have been more acceptable to the critic, whom the author disarms so winningly in his preface. There is order and logic and development; but I think rather of the author as inviting the reader to make a journey to the mountain peaks of his ambition and turning him aside at times to explore the valleys and the foothills; and occasionally the interest of the valley seems to hide the distant peaks. They are never reached, being, indeed, unattainable, but they are always being brought nearer and the journey proves of absorbing interest and, though it takes more time, it is free from the weariness of the long straight road. Or again I think of a wonderful palace with the rooms all arranged and full of objects of use and of beauty and of great variety, and of some objects of whose presence I cannot as yet apprehend the reason; all the rooms are different, but, as I go from room to room gradually I realize that there is a unity—partly real, intentional, partly mystic—among this great variety, and that it is a far more inspiring and interesting unity than the unity of an unrolling silken thread or golden cord—of an ordered, logical theory.

My survey is ended; the book is a fine example of courage—it required some courage to write Part IV fourteen years ago and to begin it with a reference to Part I, Chapter V, not published then nor for another seven years—it required some courage to begin this volume with a discussion of the elusive quantity (or value?), " force "—but it required courage of a rarer quality to undertake, and to bring to fruition in the eighth decade of a strenuous life, this great Manual of Meteorology—full of wise guidance and fertile ideas for the rising generation of meteorologists; and for " such as are of riper years " too, but in their case with the addition of happy memories. I find these words (of the Duke of Vienna) quoted in Barrie's " Courage," and they are apt enough to express what is in my mind on this fair day of Candlemas about the spirit which has inspired the Manual :—

> " Heaven doth with us as we with torches do
> Not light them for themselves . . . . ."

E. GOLD.

Surface Horizontal Visibility with Saturated Air

By S. E. Ashmore, B.Sc.

At the end of a paper on "The Occurrence of Fog with unsaturated air at Grayshott," recently communicated to the Royal Meteorological Society, I briefly discussed the problem complementary to it, namely, the occurrence of good visibility with saturated air. The suggestion for doing this came from a remark made by Dr. F. J. W. Whipple during the discussion consequent upon the reading of Mr. W. H. Pick's paper, "A note on the Relationship between Fog and Relative Humidity."* The remark was that "one gets intensely high relative humidity and no fog." The method used was to take cases of very good visibility (L and M according to the scale used in the Meteorological Office, see Table I†) alone, and to examine their distribution through various humidity ranges. The conclusion drawn was that very good visibility can occur with high relative humidity, but that it is usually associated with drier air. This treatment is rather inadequate, and the following is the result of the converse treatment of the subject, effected by taking all the cases of saturated air over a period, and examining the visibilities accompanying them.

After having begun the work, I received a copy of Mr. Pick's paper, "Visibility with Saturated Air," read to the Society on December 16th, 1931, which treats the same problem for Felixstowe and Worthy Down. Through the courtesy of Mr. Pick I have been permitted to remodel my investigation on his.

Relative humidity at Grayshott is determined by dry- and wet-bulb thermometers exposed in the usual manner in a Stevenson screen. The criterion of saturation used was that of relative humidity over 99·5 per cent. Every occurrence of this was tabulated for the eight years, 1924-31, observations being made at 9h. daily; cases open to doubt, owing to trouble with the wet-bulb due to frost, have been excluded. The scale of visibility used is that employed in the Meteorological Office, London. It was at first intended to treat winter and summer separately, but analysis showed that in the eight years only six cases of saturated air occurred at 9h. during the summer months (April to September).

Reference to Table I, where comparison is made between the three stations, Felixstowe (coastal), Worthy Down and Grayshott (inland rural), shows that all degrees of visibility, except X, L and M, occur with saturated air at Felixstowe and Worthy Down, but at Grayshott A does not occur. A has never been recorded at 9h. at Grayshott since observations began in 1923. It is well to mention that on a day just outside the

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* *London, Q.J.R. Meteor. Soc.* 57, 1931, p. 288.

† See also *London, Meteor. Office, The Observer's Handbook*, 1926, p. 54.

period under investigation, November 9th, 1923, L was recorded with air 100 per cent. saturated. Worthy Down shows a maxi-

Station	No. of occasions of saturated air when visibility was												
	x-A <55 yds.	B 55 yds.	C 110 yds.	D 220 yds.	E 550 yd.	F 1100 yds.	G $1\frac{1}{4}$ mi.	H $2\frac{1}{2}$ mi.	I $4\frac{1}{3}$ mi.	J $6\frac{1}{4}$ mi.	K $12\frac{1}{2}$ mi.	L-M $18\frac{3}{4}$ mi. or more	Total
Grayshott.. ..	0	4	34	41	31	38	7	7	5	1	5	0	173
Felixstowe ..	10	23	31	37	23	33	22	15	5	8	0	0	207
Worthy Down ..	4	16	29	23	33	19	23	23	13	11	2	0	196

TABLE I.

mum at visibility E, while Grayshott and Felixstowe have a maximum at D, a secondary maximum at F, and a tertiary maximum at J or K. It appears that saturated air tends to produce fog or poor visibility, but that good visibility can occur, more so at Grayshott than at the other two places. Table II shows the data for Grayshott grouped under headings fog (visibility A-E), mist (F), moderate visibility (G-I), good visibility (J-M).

No. of cases of saturated air	Percentage No. of such occasions accompanied by			
	Fog A—E	Mist F	Mod. visibility G—I	Good visibility J—M
173	63·6	22·0	11·0	3·5

TABLE II.

The inference from Table II seems to be that saturated air is usually accompanied by fog or mist, but that neither may occur with it. Only 14·5 per cent. of cases of saturated air were unaccompanied by fog or mist. This does not agree at all well with Mr. Pick's results for Felixstowe, or even for Worthy Down. At the former station 24 per cent. of cases were unaccompanied by fog and mist, and at the latter, 41 per cent.

Table III shows the effects of wind speed on visibility accompanying saturated air :—

Wind force (Beaufort)	No. of occasions of saturated air	No. of such occasions accompanied by			
		Fog A—E	Mist F	Mod. vis. G—I	Good vis. J—M
Calm 0	43	31	4	5	3
1	69	41	19	7	2
2	33	24	8	1	0
3	20	13	3	4	0
4	3	1	1	1	0
5	5	0	3	1	1

TABLE III.

Table III shows that when saturated air is accompanied by wind forces 0, 1, 2 or 3 on the Beaufort Scale, the most likely

state of the visibility is fog, but this probability decreases with increasing wind speed. With forces 4-6 it is more likely that there will be mist, moderate, or good visibility. This is in fairly good agreement wth the results for Felixstowe and Worthy Down obtained by Mr. Pick.

Discussions at the Meteorological Office

February 1st, 1932.—*Investigations concerning the variations of the general circulation.* By A. Wagner (Geog. Ann., Stockholm 11, 1929, pp. 33-88) (in German). *Opener*—Dr. C. E. P. Brooks.

This paper discusses the differences between conditions during the two ten-year periods, 1886-95 and 1911-20. Since direct comparison of wind velocities is not practicable, the strength of the atmospheric circulation is measured by the distribution of pressure, and its effects by the distribution of temperature and precipitation. The basis of the investigation is the mass of data in "World Weather Records."

In the chart of pressure differences, 1911-20 minus 1886-95, the most noticeable feature is a deepening and extension of the Icelandic low, connected with the deepened Aleutian low by a trough of negative values which practically encircles the globe. There is evidence of a similar trough of negative values in the southern low-pressure belt. In high northern latitudes, pressure has risen, and there is also a broad equatorial zone of increased pressure, most marked in the anticyclonic centres. In other words, pressure contrasts have become accentuated over the whole world, demonstrating an increase in the strength of the atmospheric circulation. This is attributed to an increase in the strength of the incoming solar radiation, which may be due partly to an increased .solar constant but mainly to increased transmission by the atmosphere of short wave-lengths.

Mean annual temperature has in general increased over the continents, but over the oceans the increase is counter-balanced by increased mixing due to stronger winds. Thus, although the amount of heat received by the oceans may be greater, the surface temperature is not raised. A stronger circulation carries more heat from low to high latitudes, but the increase is greatest in winter, when the thermal contrasts are greatest. Hence the annual range has increased near the equator and decreased in temperate regions; also the balance between radiation and temperature is changed, so that the extremes of temperature are retarded in low latitudes and advanced in high latitudes, the dividing line occurring where the annual inward and outward radiations balance. Changes in the amount of precipitation also follow changes of pressure, the most notable feature being an increase in the amount of orographic rain.

The author considers that most of the correlations between

distant regions found by Sir Gilbert Walker and others are due to connexions with the general circulation, changes in which have considerable persistence. Thus, the general circulation forms the true basis of long-range forecasting, and it may eventually be possible to relate it to solar changes.

The subjects for discussion for the next two meetings will be :—

February 29th, 1932.—*The mixing question, viewed theoretically and practically together with a consideration of internal waves.* Discussions and report by W. W. Ekman, G. I. Taylor and H. Thorade (Copenhagen, Cons. perm. Inter. l'exploration de la Mer. Rapports et Procès Verbaux des Réunions, Vol. 76, 1931). *Opener*—Mr. E. L. Davies, M.Sc.

March 14th, 1932.—*Essay on the structure of a burst of warm air* (October 16th-18th, 1928). By Hellmut Berg (Beitr. Geophysik, Leipzig, 30, 1931, pp. 1-30) (in German). *Opener*—Dr. W. A. Harwood.

Royal Meteorological Society

The Annual General Meeting of this Society was held on Wednesday, January 20th, at 49, Cromwell Road, South Kensington, Mr. R. G. K. Lempfert, M.A., F.Inst.P., President, in the Chair.

The Symons Gold Medal, which is awarded biennially for distinguished work in connexion with meteorological science, was accepted by the Norwegian Minister on behalf of Prof. V. Bjerknes, of the Physical Institute of the University, Oslo, to whom it had been awarded by the Council.

The Report of the Council for 1931 was read and adopted, and the Council for 1932 duly elected, the new President being Prof. S. Chapman, F.R.S.

Mr. R. G. K. Lempfert delivered an address on : " The Presentation of Meteorological Data," of which the following is an abstract :—

Meteorological data are accumulating with ever increasing rapidity. Our *Daily Weather Report*, for example, contains more than 3,000 facts for British stations in a single issue, and there are also 250 stations in the *Monthly Weather Report* and 5,000 in the British Rainfall Organization. Questions of exposure require great care, for example, a steady decrease of wind velocity shown by the records from Glasgow Observatory may perhaps be due to the activities of Glasgow's builders rather than to meteorological causes. The method of presentation of all these facts is important; summaries are essential, and in this country these are given in the *Weekly* and *Monthly Weather Reports*. Monthly summaries are published according to an international form, the essentials of which were devised in 1874. It is by no means easy to maintain continuity in a series of

observations over a long period of years. Changes of procedure, such as the adoption in 1921 of the day maximum and night minimum instead of extremes for 24 hours, can hardly be avoided. Non-instrumental observations present still greater difficulties, yet when such observations are plotted on maps they bring out many interesting climatological relationships. Fog has been especially unsatisfactory in the past, but owing to the demand for precise information for aviation the criteria for fog and visibility have been greatly improved in the past ten years.

Since 1874 many additions have been made to the international summary form, such as information about coldest days and warmest nights, and the number of days with rainfall, temperature or sunshine between specified limits. The more general use of autographic instruments suggests that the idea of duration between specified limits which has already been introduced into the presentation of statistics of wind might be extended with advantage to other elements, more particularly to the element, humidity, for which the present summaries of observations at 9h. and 21h. give an ineffective representation. Some specimen tabulations of the duration of humidity are far more informative. A distinguished botanist has suggested that the "saturation deficit" should be given, and a specimen table for one week was shown, which illustrated clearly how regularly the deficit fell below 6mb. during the night hours between 20h. and 9h., suggesting that the air has then no appreciable drying power.

Correspondence

To the Editor, *The Meteorological Magazine.*

Solar Haloes and Mock Suns at Cambridge

On January 14th of this year a very striking development of solar haloes and accompanying phenomena was observed from this college. About 1.30 p.m. I saw that the sun, then partly obscured by clouds, was surrounded by an unusually good example of the common halo. Further, on either side of the sun and at the same level, there were two specially bright "mock suns." For a few minutes, about 1.45 p.m., these were so vivid that it was almost painful to look at them directly, and in fact they were nearly as bright as the real and partially obscured sun. Vertically above the real sun there was a small patch on the halo in which the colours were specially clear: red on the concave side of the arc. Concentric with the first-mentioned halo, and with about double the radius, was another exactly similar halo, very faint, but with the colours in the same order: red inside. Touching the highest point of this second halo there was also an inverted bow, in which the colours were extraordinarily vivid, even when seen against an almost clear blue

sky. In this case the blue was on the concave side. This bow, which was very short, was as bright as many common raindrop bows, only it was upside down.

I measured with a prismatic compass the radius of the inner halo and found it to be 21-22°, the ordinary ice-crystal halo radius, but I could not get a measurement for the second halo. I estimated it as about double that of the first, and I am told that it should be about 46°. The agreement is good enough.

The notable features seem to be: (1) the brightness of the mock suns; (2) the occurrence of both inner and outer haloes; (3) the brightness of the inverted bow at the top.

The outer halo and the inverted bow disappeared very quickly, but the inner halo, the mock suns and the bright coloured patch above the sun were still faintly visible almost up to sunset.

R. H. RASTALL.

Christ's College, Cambridge. February 3rd, 1932.

Winter Minimum Temperatures on Mountains

In 1923 I placed a thermometer in the cairn at the top of Ben Chonzie (Ben-y-Hone), 3,048 ft., here with a view to recording perhaps some zero or minus temperatures during the winters.

In the nine following winters the following are the minima recorded by this thermometer, to which I have appended the minima at Auchnafree (1,015 ft.):—

	Ben Chonzie.	*Auchnafree.*
1923-4	9	—
1924-5	9	14
1925-6	5	7
1926-7	—	13
1927-8	—	9
1928-9	7	6
1929-30	10	6
1930-1	13	12

The thermometer necessarily has to be built well into the cairn, so as not to be tampered with by tourists or others, and so may possibly be unduly sheltered by snow. At the same time the readings bring out the recognised fact that in very cold weather it is on the low ground and not on the highest spots that minimum temperatures are experienced.

With the temperature at 50° at Auchnafree, that on Ben Chonzie is generally 7-8° lower, and when 30° at Auchnafree, generally 4° lower. At still lower temperatures the difference between the two is less, or none, but it seems that a minus temperature is more likely to occur at Auchnafree than on Ben Chonzie.

J. A. C. WHITAKER.

Auchnafree Lodge, Dunkeld, Perth.

[It may be of interest to add that during the considerable

period (1883-1904) in which the observatory on Ben Nevis (4,404 ft.) was in operation the minimum, in a Stevenson screen, never fell below 0°F., though temperatures as low as 2° or 3°F. were experienced in conjunction with winds of over gale force. —A. H. R. GOLDIE.]

Unusually persistent Rain

The following data of the exceptional rainfall recorded here from January 1st-3rd of this year may be of interest to you. The weather during this period was remarkable for four reasons: (1) the persistency of the rain, (2) slight movement of barometer, (3) lightness of wind, (4) continued high air temperature.

Date	*Rainfall*	*Temperature.* *Max.*	*Min.*	*Wind at 9h.*
	in.	°F.	°F.	
1st	0·83	48·6	44·2	SW. 3
2nd	2·09	51·6	48·6	SW. 2
3rd	1·17	54·6	51·6	SW. 2

The total fall for the 72 hours was 4·09 in.

As reported in newspapers there was severe flooding in the Clyde Valley and surrounding districts.

It will also be noted that the temperature rose continuously from 44·2° at 21h. on December 31st to 54·6° at 11h. on January 3rd. The barograph trace showed a drop of 0·43 in. from 12h. on the 31st to 8h. on the 1st, thereafter it remained constant to 10h. on the 3rd, showing the diurnal variation in that period, the average being 29·56 in.

KENNETH M. TOPPING.

71, Gala Street, Riddrie, Glasgow. January 10th, 1932.

NOTES AND QUERIES

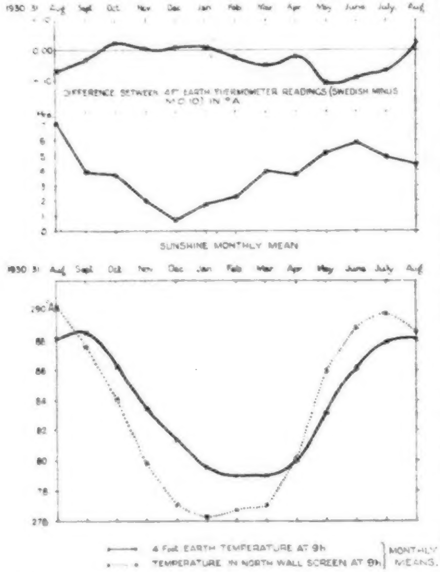
Note on a comparison between readings of two 4-ft. earth thermometers

The records of earth temperatures at meteorological stations in this country are usually derived from Symons thermometers. These are ordinary mercury thermometers with their bulbs covered by paraffin wax and protected by glass jackets. Strong iron tubes with closed pointed ends are driven into the ground and the thermometers are hung by chains so that the bulbs may be at the prescribed depths, usually 1 ft. or 4 ft. below the ground level. The tops of the tubes are covered by caps mounted on wooden plugs, which fit loosely and to which the chains are attached.

At Kew Observatory there are two 1 ft. thermometers of this type, and one 4 ft. The thermometers are read at 9h. The paraffin lags the thermometers efficiently, so that no error can be introduced by bringing them up to the open air. The thermo-

meters are graduated on the Absolute (Integral Freezing Point) scale. The 4 ft. thermometer requires (according to the N.P.L. certificate, dated 1913) corrections $+0{\cdot}1°$ at 273° and at 290°. $+0{\cdot}2°$ at 280°. It has been customary to apply the correction $+0{\cdot}2°$ to readings up to 285° and the correction $+0{\cdot}1°$ to readings above that limit.

In the summer of 1930 a 4 ft. thermometer of the type which has been devised in Sweden by A. Angström and E. Petri was sent to Kew Observatory by the Meteorological Office for trial. The Swedish pattern differs from the Symons in several respects. A smaller thermometer is used, and instead of the bulb being surrounded by paraffin wax it is in a vacuum. According to the diagram issued by the makers the clearance between jacket and bulb is about 1 mm. There is a thick coat of enamel paint outside the jacket. The temperature reading rises pretty rapidly when the thermometer is held in the hand, but it is unlikely that readings would be affected in the ordinary routine. In place of the iron tube a vulcanite tube of much smaller bore is used. At the bottom of the tube there is a copper shoe, inside which is a small rubber cushion. The thermometer jacket, which is a little less than 1cm. in diameter, passes readily down the tube. The thermometer is attached to a cord from a button which rests on top of the vulcanite and a metal cap screws on to the vulcanite and covers the button. No certificate was received with the thermometer, which is graduated in half degrees Fahrenheit. Comparison with the Kew standard thermometer, M.O. 514, gives the correction $+0{\cdot}5°$ F. After application of this correction, the daily readings of the Swedish thermometer have been converted to °A and compared with those of Kew standard thermometer M.O. 10.



In the first instance the corrections mentioned above were

applied to the readings of thermometer M.O. 10, but it was realised that the discontinuity in the correction at 285° was misleading and a flat correction of +0·1° was substituted. On this basis the agreement between the two thermometers is very satisfactory. The difference in readings (Angström-Petri minus Symons) varies from −0·2° to +0·2°. In the 12 months September, 1930-August, 1931 −0·2° occurred 17 times in March to July and once in November, whilst +0·2° occurred twice in August. The monthly means fluctuate between −0·11° and +0·02°.

As will be seen from the graph there is close agreement from October to April, but a discrepancy of 0·1° A appears in May, June and July. In these months the Symons thermometer gives the higher reading. The differences are consistent with the hypothesis that heat conducted down the iron tubes raises appreciably the temperature at 4 ft. during the hottest months. The excess is of the order 0·1° A or 0·2° F.

The comparisons under review do not serve for the estimation of such small differences, as the calibration of the thermometers is not sufficiently precise. It is therefore being arranged that one thermometer, the Swedish one, shall be placed on alternate days in one tube or the other. Preliminary readings indicate that in November with temperature falling from day to day the iron tube gives lower readings at 4 ft. than the vulcanite tube. The difference is 0·1° F.

It appears to be desirable to conduct the comparison on these lines for a year before assessing the advantage of the substitution of vulcanite for iron. One lesson learned from this investigation may be emphasized. For such work it is not desirable to apply thermometer corrections in such a way that the corrections change at points selected by some arbitrary rule. It is better to apply uniform corrections and, if necessary for the purpose in hand, make adjustments in final results.

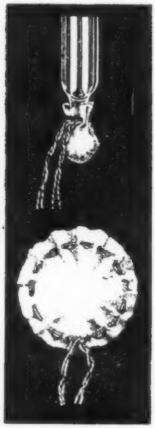
Changes in Italy

On November 1st, 1931, Professor Luigi Palazzo retired from the Directorship of the R. Ufficio Centrale di Meteorologia e Geofisica. Professor Palazzo joined the Italian Meteorological Office in 1888 and became Director in 1900. He has been succeeded by Professor Comm. Emilio Oddone, the senior Geophysician.

Professor Giovanni Agamennone, having reached his 73rd year, retired on November 1st, 1931, from the post of Director of the R. Istituto Geofisico di Rocca di Papa, Rome, which he has held for 32 years and also from the post of Head of Geophysics at the R. Ufficio Centrale di Meteorologia e Geofisica, which he has held for two years.

Muslin caps for wet-bulb thermometers

Acting on a suggestion by Dr. E. Kidson, Director of the Meteorological Service in New Zealand, a trial has been made of muslin caps for fitting to wet-bulb thermometers in place of the muslin and wick which has been used in the past for this



purpose. The trial having proved satisfactory the method has been adopted by the Meteorological Office and issues of these caps can now be made to private observers who desire to purchase them. The caps are supplied in packets of 20 at 1s. per packet. They are, however, readily made, and as observers may in many cases prefer to make them up from the muslin and wick supplied by the Meteorological Office instead of buying them, the following instructions are given :—

A circular piece of muslin should be cut $1\frac{1}{2}$ inches in diameter. Two threads of wick should then be threaded round the muslin about $\frac{1}{8}$ inch from the edge in the manner shown in the illustration the thread being pulled through so that the four loose ends are of equal length. The cap is then ready for use. When fitting it to the thermometer bulb it should be placed over the bulb and the threads pulled through the muslin so that the cap is held firmly round the neck. The threads may be left untied, the friction of the thread in the muslin alone being sufficient to prevent the thread from working loose. The loose ends of the thread will be found to be long enough to reach the water container.

Storage of Balloons in Turpentine and Paraffin Vapour

In the *Meteorological Magazine* for January, 1928, Dr. Knox-Shaw gave an account of his successful experience with the preservation of balloons and other rubber goods by storing them in a cupboard in the presence of turpentine vapour.

The storage of pilot balloons is a matter of great importance to the Meteorological Office and it was accordingly decided to carry out a thorough test of this method of storage. In August, 1930, 500 70-inch balloons (*i.e.*, balloons 70 inches in circumference when distended) were placed in a cupboard which was kept saturated with turpentine vapour by a tray of turpentine at the bottom. A suggestion having been received that paraffin vapour might prove more efficacious than turpentine vapour, 100 balloons were stored in a similar way in paraffin vapour. The storage cupboards were placed in a small iron hut, without opening windows or ventilator, on the roof of the Meteorological Office at South Kensington, where they were exposed to con-

siderable fluctuations of temperature and to strong solar heating in the summer. Samples of the balloons both when new and at periodic intervals were issued for test to Croydon and Lympne in this country and also to the stations in the Middle East Area, careful note being kept of their behaviour. Apart from this special note of their behaviour, the balloons were used in the normal way, their use being spread over several weeks from the date of receipt at the station. They were thus exposed to the normal deteriorating effects of air storage for a time after removal from the special storage cupboards. Issues of turpentine vapour balloons were made at intervals of 3, 6, 9 and 12 months after storage and of paraffin vapour balloons at intervals of 6 and 12 months. In the summarized results given below the balloons are classified as bad when they burst before being completely filled or during the early stages of an ascent, and good when they gave a successful ascent. The effect of the different periods of storage in turpentine vapour is shown in the following table :—

	Lympne and Croydon.		*Middle East.*	
	Bad.	*Good.*	*Bad.*	*Good.*
Balloons when new ...	2	40	4	42
3 months' storage ...	4	39	3	42
6 ,, ,, ...	5	40	4	41
9 ,, ,, ...	5	40	6	39
12 ,, ,, ...	9	25	6	30

The figures seem to indicate a marked deterioration between 9 and 12 months in the balloons used in this country, while in Middle East the results after 9 and 12 months showed a much less striking difference. The results obtained in Middle East which indicate 5 serviceable balloons to one unserviceable balloon after 12 months' storage are satisfactory.

The balloons stored in paraffin vapour showed practically no deterioration in England or Middle East when used after 6 months' storage. The figures are given below, together with those after 12 months' storage :—

	Lympne and Croydon.		*Middle East.*	
	Bad.	*Good.*	*Bad.*	*Good.*
Balloons when new ...	2	40	4	42
6 months' storage ...	2	22	0	24
12 ,, ,, ...	3	13	2	12

These results seem to indicate that paraffin vapour is slightly superior to turpentine vapour in its preservative properties. Reports received from the testing stations showed that some of the turpentine vapour balloons when received had their sides stuck together. This seems to have been one of the chief causes of failure.

In addition to the above field tests a few samples were tested in the Meteorological Office laboratory by blowing them up to

destruction on the small air blower which is used for testing balloons. This blower fills a standard 70-inch balloon in 30 seconds and the time taken to burst a balloon gives a good indication of its volume at the time of bursting. Good quality balloons will always exceed the nominal circumference, sometimes by a considerable amount. Six of the balloons tested when new gave an average time of bursting of 90 seconds. After 9 months 3 balloons stored in turpentine vapour gave a time of 68 seconds, while 3 stored in paraffin gave 78 seconds. After 12 months the times were: turpentine 87 seconds, paraffin 93 seconds. These laboratory test figures thus show no appreciable deterioration after storage for 12 months.

A few balloons were left in the cupboards for a further period of 4 months. At the end of this time the balloons over turpentine vapour had deteriorated somewhat, but the turpentine had not been renewed for some months and had probably lost its effectiveness. The paraffin vapour balloons gave a bursting time of 82 seconds and were thus practically as good as new.

The general conclusion reached from the experiments is that paraffin vapour is somewhat superior to turpentine vapour and that either is of great value for preserving rubber pilot balloons for a period of 12 months. None of the balloons were kept in air for so long a period as 12 months, but there is little doubt from past experience that before the expiration of this time balloons so stored would have become almost useless.

The High Pressure of January, 1932

For several days before January 20th, pressure remained high on the continent, while depressions skirted the west and north-west coasts, so that a very mild southerly or south-westerly type of weather prevailed. By the 20th the greater part of the country had come under the influence of the continental high, which was periodically re-inforced by a new high spreading in from the west with a consequent shift of the centre of the continental anticyclone towards the British Isles. By the 26th, the anticyclone with its central area over the midlands and North Sea had attained its maximum intensity, so that barometer readings over most of England on this day were the highest for many years. At Ross-on-Wye the reading (1048·5 mb.) was the highest ever known, and at Birmingham (1049·4 mb.) it was a record for the last 45 years. The highest pressures recorded on the 26th were 1050·2 mb. at Cranwell and 1050 mb. at Harrogate. The barometer remained above 1049 mb. in many parts of the midlands and the east coast. It is to be noted that the pressure values given in this note are corrected for temperature and reduced to mean sea level.

After the 26th, pressure fell slightly over the country as the anticyclone, decreasing in intensity, moved slowly south-

eastwards to the continent. Later the continental anticyclone moved north-eastwards, increased in intensity, so that by the 31st it was again centred over the British Isles giving a maximum barometric pressure of 1045·9 mb. at Sealand. Anticyclonic conditions continued during the early part of February.

It is recognised that in winter two distinct types of anticyclones occur over the British Isles; in one, the sky is covered with a layer of stratus cloud, conditions which are referred to as "anticyclonic gloom," and in the other, the sky is almost cloudless and the nights are frosty. The first anticyclone of January 25th-27th appears to have both the above characteristics, because on the 25th the south-east sector was completely overcast with stratus clouds, whereas north of a line Cork-Tynemouth the sky was almost cloudless. Due to this anticyclonic gloom in the south-east low maximum temperatures were recorded, 38°F. at Kew being the maximum for the 25th. Similarly, owing to the clear skies of the north-west sector of the anticyclone allowing radiation at night, the lowest screen and grass minimum temperatures were recorded in northern districts, such as a screen minimum of 18°F. at Eskdalemuir and a grass minimum temperature of 12°F. at Catterick on the night of the 25th-26th.

With the movement eastwards of the anticyclone on the 26th, the cloud amount decreased slightly in the south-east but increased in the north owing to the approach of a depression, so that the lowest maxima were recorded in the northern districts: such as 35°F. at Eskdalemuir on the 26th, 32°F. at Stonyhurst on the 27th, and 30°F. at Birmingham on the 28th. The clear skies still persisted on the north-east coast on the 26th, and owing to night radiation the lowest temperatures were a screen minimum of 26°F. and a grass minimum of 11°F. at Catterick.

Fog, however, was much more widespread during the second but less intense anticyclone.

A period of high pressure prevailed over Scotland during the second week of January, 1896, when an anticyclone moved westward from the continent of Europe over the British Isles, where it combined with another anticyclone lying off our north-west coasts, and increased suddenly in intensity. At 8 a.m. on January 9th, the barometer exceeded 1050 mb. over the whole of Scotland, the first appearance of that isobar on our weather charts. The highest reading was 1054·4 mb. at 9 a.m. at Ochtertyre, Perthshire. After the 9th the whole system moved away south-westwards, but a remarkable return of high pressure occurred at the end of the month when the barometer rose to 1048·9 mb. at Valentia, Ireland. A peculiarity of both these anticyclones in January, 1896, was the mild weather associated with them—on both occasions temperature was almost everywhere above freezing point.

W. R. Morgans.

Reviews

Kentucky Geological Survey. Series 6, vol. 31. The Pleistocene of northern Kentucky, The Climate of Kentucky, and other papers. Frankfort, Kentucky, 1929.

For meteorologists the main interest in this volume of papers from the Geological Survey of Kentucky is in the second contribution, "The Climate of Kentucky," by Dr. S. S. Visher, a profusely illustrated memoir of 85 pages. The state, in an area rather more than two-thirds that of England and Wales, comprises nearly seventy stations, sufficing to give the distribution of the various meteorological elements in some detail, though as the greatest extent is from east to west, the variation is generally small. On the other hand, the charts illustrate clearly the increasing continentality from east to west. Apparently in calculating the average temperatures, no correction is applied for the differences of elevation, ranging from 300 to 1,400 feet. The 109 illustrations include a number showing average dates of killing frosts, vegetative periods for different crops, and much other material of value to farmers. The method adopted is rather unusual; the charts do not so much illustrate the text as run parallel with it, each chart being given a generous legend which makes it self-explanatory. This makes reference easy, which was probably the author's intention, but tends to encourage turning the pages at the expense of steady reading. The paper concludes with an interesting description of the effect of the warm humid climate of Kentucky on the relief of the ground, and especially of the formation of "swallow holes" in limestone country.

India Meteorological Department, Scientific Notes, Vol. II, No 15, Winds in higher levels over Agra, by N. K. Sur, D.Sc., *No. 16, Winds in the first 3Km. over Port Blair,* by K. P. Ramakrishnan, B.A., and No. 17, *Tables of monthly average frequencies of surface and upper winds up to 3Km. in India, Parts A, B, C and D.*

The conclusions in the first paper, drawn from the analysis of two years' observations at Agra, are briefly that (i) in the weak winds of the summer monsoon no marked change of speed occurs at the tropopause; but the strong north-westerly or westerly winds of winter, which increase from 1Km. to 14Km., show a marked tendency to decrease from 14Km. to 15Km. Data are, however, scanty at this level. (ii) Up to 14Km. pilot balloons show north-westerly or westerly winds during the whole year, but in vigorous summer monsoons clouds show easterly winds. (iii) The few observations obtained indicate a change from south-westerly to north-easterly winds in the monsoon on entering the stratosphere, and a change from north-easterly to north-westerly through south-west above 20Km.

The author's aim in the second paper was to find with what

accuracy wind, and consequently air-trajectories in the neighbourhood of tropical depressions, could be estimated from the pressure gradient indicated by the Indian daily weather charts. Data extending from July, 1926, to June, 1928, were used. The results indicate that monthly mean wind at 0·5Km. and 1Km. agrees fairly well with the gradient wind, but the agreement on individual days is poor. Many of the deviations are accounted for by orography, but there are also deviations due to systematic horizontal temperature gradients in both the winter and summer monsoons.

The four parts of the third paper contain pilot balloon data in the form recommended by the International Commission for Air Navigation. The stations included are:—A—Bahrein, Muscat, Jask, Gwador, Karachi, Quetta, Peshawar, Lahore, Simla and Ambala; B—Ahmedabad, Ajmer, Agra, Jubbulpore, Patna, Ranchi, Calcutta, Dacca, Rangpur and Tezpur; C—Chittagong, Mandalay, Akyab, Rangoon and Port Blair; D—Poona, Waltair, Mangalore, Bangalore, Madras, Trincomalee and Colombo.

Standard Meteorological Instruments, List M.2, and *Mercury-in-Steel Thermometers*. Pp. 140 and pp. 40. *Illus.* Negretti & Zambra, London, 1931.

We have received from Messrs. Negretti & Zambra a copy of their latest catalogue of meteorological instruments, which contains almost every kind of such instrument used in this country. Messrs. Negretti & Zambra have spared no pains to make this catalogue not only an attractive advertisement for the sale of their instruments, but they have also produced a book of reference and explanation for all who are interested in those instruments appertaining to the science of meteorologoy.

In drawing up this catalogue Messrs. Negretti & Zambra have studied the interests of the amateur as well as the most exacting observer. For the information, especially of the latter and for those abroad, permission was obtained from the Director of the Meteorological Office to embody in the catalogue extracts from official specifications of the instruments used by the Meteorological Office. The inclusion of instruments made to official specifications is all to the good. Not only does it make the catalogue more comprehensive and enable the interested public to know the kind of instruments used by the Meteorological Office, but there is set before the prospective purchaser, from which he is free to choose according to his needs, a set of instruments ranging from what may be termed the standards for official use, which can be supplied with certificates of accuracy by the National Physical Laboratory, to those that will meet the requirements of the class room.

This is a catalogue for the meteorological observer *par*

excellence so that instruments often to be observed in the home are absent. It is to be regretted that space could not have been found for an illustration of the up-to-date sunshine recorder used in this country, for this incorporates an adjustable sub-base for accurate levelling and for positioning in the meridian. Some readers may be misled by the name microbarograph, the name given in the catalogue, pages 41 and 42, to the large scale barograph. The term "microbarograph" is reserved by the Meteorological Office for the instrument (not catalogued) designed by Dines and Shaw for recording small and rapid variations of atmospheric pressure, while the barograph with greatly amplified scale, such as that listed in the catalogue, is named by the Meteorological Office, the open scale barograph.

For those interested it should be mentioned that there are included in the catalogue a number of test apparatus for the calibration of thermometers, barometers, aneroids, hygrometers and anemometers.

The catalogue is beautifully printed and profusely illustrated on art paper and handsomely bound, and Messrs. Negretti & Zambra are to be congratulated upon producing a very fine and useful volume.

We have also received from the same makers an illustrated brochure entitled "Mercury-in-Steel Thermometers." This is a revise of their pamphlet "Notes on Distance Thermometers." In it are discussed at some length the relative merits of gas, vapour and liquid distant reading thermometers. The errors inherent in such instruments are frankly stated and examined, and the various methods devised and adopted for overcoming them or reducing them to negligible proportions set forth.

J. E. BELASCO.

Books Received

Falmouth Observatory. Meteorological Notes and Tables for the year 1930. Also additional meteorological tables for the lustrum 1926-1930, with mean values for 60 years (1871-1930) by W. T. Hooper. Falmouth, 1931.

Nautisk-Meteorologisk Aarbog, 1930. The Danish Meteorolgical Institute, Copenhagen, 1931.

Functions and Organisation of the India Meteorological Department (1931). Delhi, 1931.

Brown's Distance Chart. Distances between all the principal parts of the world. Brown, Son and Ferguson. Glasgow, 1931.

News in Brief

We learn that Capt. F. Entwistle, Superintendent of the Aviation Services Division of the Meteorological Office, has accepted the editorship of the *Sailplane*, the journal of the

British Gliding Association. Capt. Entwistle proposes himself to qualify as a glider pilot.

Erratum

January, 1932, p. 288, line 19: *for* " Baltasound, Kirkwall, Orkney," *read* " Halligarth, Baltasound, Shetland."

The Weather of January, 1932

Pressure was above normal over the whole of southern and central Europe, Denmark, Gothaland (Sweden), England, north Africa, and from southern Greenland to the Bermudas and Florida, the greatest excess being 12·9 mb. at Cagliari, and 5·1 mb. at 60°N.60°W. Pressure was below normal in a belt extending from northern Europe and Spitsbergen across Iceland to the central part of the North Atlantic, including the Azores, the greatest deficit being 8·7 mb. at Vardo. Temperature was above normal over the whole of north-west and west Europe and Spitsbergen, as much as 13°F. or more above normal in half Norrland, and below normal in south-west Europe. Rainfall was generally in excess in western Europe, but deficient in northern Norway and Spitsbergen. In Sweden it ranged from double the normal in western Lapland to one-third of the normal in south-eastern Gothaland.

Over the British Isles the weather of January was very mild and unsettled with south-westerly winds until about the last ten days, when it became anticyclonic with temperatures about normal. Rainfall was generally in excess—more than twice the normal in south-west Scotland—but deficient along the eastern coasts of England. During the first two days there was a continuous and rapid rise of temperature as a depression approached from the Atlantic, and the night of the 2nd-3rd was the warmest January night on record at several places; at Tynemouth the minimum temperature was 55°F., at Chester, Liverpool, Donaghadee, Birr Castle, Valentia and Greenwich 54°F. For the next two or three days the weather was mild and stormy with depressions moving north-east along the north-western seaboard. Gales occurred in the west and north-west, sunshine was poor and rain general and heavy at times; 4·16 in. fell at Borrowdale (Cumberland) on the 2nd, 2·10 in. on the 5th, at Oughtershaw (Yorks) 2·18 in. on the 2nd, 2·01 in. on the 5th, and at Llyn Fawr 3·42 in. on the 5th. On the 5th and 6th gales also spread to the south and Midlands, but by the 7th the winds had veered and moderated and the country came under the influence of polar air, bringing snow and sleet to Scotland and north Ireland. The 7th and 8th were both sunny days, Bath and Weymouth both had 6·9 hrs. on the 8th. Subsequently depressions continued to move along the north-west seaboard and very

mild weather with south-westerly winds was renewed. Strong winds and gales prevailed frequently, especially in the west and north from the 9th to 19th, and rainfall was heavy at times until about the 14th or 15th, when thunderstorms occurred generally in the west; at Holne (Devon) 4·15 in. of rain fell on the 9th, 2·87 in. on the 12th, at Borrowdale 3·81 in. on the 9th, and at Goytre Hall (Monmouth) 2·89 in. on the 9th. Sunshine records were good on many days, the sunniest days being the 12th and 15th. On the 18th, day temperature reached 60°F. at Llandudno, 59°F. at Dunbar, York and Bude. About the 20th the continental high-pressure area spread westward, and anticyclonic conditions set in and persisted until the end of the month. Some record high-pressure readings were registered.* Mist or fog occurred frequently on most days and sunshine was therefore rather variable but good at times. The 21st, 24th (only in the north), 25th and 30th were the sunniest days, 8·0 hrs. at Dover on the 21st and 7·9 hrs. at Eskdalemuir were the biggest amounts reported. There was slight rain or drizzle locally except in the eastern districts. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	20	— 8	Liverpool	58	+ 3
Aberdeen	72	+24	Ross-on-Wye	48	+ 2
Dublin	57	0	Falmouth	46	—12
Birr Castle	41	— 8	Gorleston	55	— 1
Valentia	29	—19	Kew	38	— 5

The special message from Brazil states that the rainfall there was irregular in the northern regions with 0·12 in. above normal, very plentiful in the central regions with 1·06 in. above normal, and scarce in the southern regions with 1·34 in. below normal. The crops were affected by the small rainfall, but the yields of cotton and cane were good. Five anticyclones passed across the country. At Rio de Janeiro pressure was 2mb. above normal and temperature 1·6°F. below normal.

Miscellaneous notes on weather abroad culled for various sources.

At the beginning of the month the weather was cold but fine in northern Italy and cold and stormy in central and southern Italy; the hills round Rome were covered with snow on the 1st, skiing was possible in Sicily on the 3rd, and gales caused shipwrecks in the Adriatic. The whole surface of the harbour of Shibenik on the Dalmatian coast of the Adriatic was frozen over on the 3rd, and several deaths due to the unusual cold occurred in Catalonia, while communications were interrupted in Hungary owing to the heavy snowfall on the 2nd. Heavy rain on the 6th and 7th caused a rise of the Meuse and its tributaries.

* See p. 18.

Florence was enveloped in fog over the 16th and 17th, which is unusual, and fog was experienced in Rome on the 17th. Severe gales occurred near the Faroes on the 17th, causing much damage to ships. Mild weather was experienced in Stockholm about the 25th. (*The Times*, January 2nd-26th, 1932.)

Many villages in the Cape Midlands (South Africa) were still isolated early in the months by the floods which occurred at the end of January. These did much damage to farms and railways. Unusually wet, cold and snowy weather prevailed in Algeria at the beginning of the month and in consequence a landslide occurred near the Palestro Gorges on the 13th. (*The Times*, January 4th-15th, 1932.)

A hurricane swept across Bali and Lombok, two islands in the Dutch East Indies, at the beginning of the month and 13 people were drowned in the swollen rivers. (*The Times*, January 8th, 1932.)

Great heat was experienced in New South Wales during most of the month and numerous and widespread fires broke out, doing much damage. At Sydney a temperature of 106°F. was reported and two people died of the heat. At the end of the month several towns in the State suffered from violent storms. (*The Times*, January 5th-23rd, 1932.)

About the 14th, while most of the prairie country was suffering from low temperatures, the Central Province of Canada were enjoying almost summerlike weather with the thermometer about 50°F. At the same time a heat wave passed over New York, where a temperature of 68°F. was registered on the 13th and 14th, which is a record there for January. Eleven people were killed and over 100 injured in a tornado which swept the Alabama-Mississippi border on the 12th. The floods caused by the overflowing of the Mississippi, Tallahatchie and Yazto Rivers extended for a distance of 200 miles on the 17th. Twenty thousand Indians in their villages in the canyons and mesas of western New Mexico were cut off from civilization by one of the heaviest snowstorms ever known there about the 17th. Temperature was considerably above normal over the United States throughout the month, except in parts of the Mountain Region and along the Pacific coasts. Along parts of the Atlantic coast it was more than 20°F. above normal during the week ending the 19th. Rainfall was generally in excess early in the month but deficient later. (*The Times*, January 14th-19th, and *Washington, D.C., U.S. Dept. Agric. Weekly Weather and Crops Bulletin.*)

Rainfall, January, 1932—General Distribution

England and Wales	111	per cent of the average 1881-1915.
Scotland	150	
Ireland	122	
British Isles	123	

Rainfall : January, 1932 : England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square.........	1·60	86	*Leics* .	Belvoir Castle...........	·96	54
Sur .	Reigate, Alvington.....	3·10	129	*Rut* .	Ridlington...............	1·11	60
Kent .	Tenterden, Ashenden...	3·13	145	*Linc* .	Boston, Skirbeck........	·96	59
,, .	Folkestone, Boro. San..	1·59	...	,, .	Cranwell Aerodrome...	·70	41
,, .	Margate, Cliftonville...	·85	51	,, .	Skegness, Marine Gdns	·95	55
,, .	Sevenoaks, Speldhurst	2·13	...	,, .	Louth, Westgate........	1·58	73
Sus .	Patching Farm.........	3·11	119	,, .	Brigg, Wrawby St......	·95	...
,,	Brighton, Old Steyne..	2·02	83	*Notts* .	Worksop, Hodsock......	1·04	59
,, .	Heathfield, Barklye....	4·19	155	*Derby* .	Derby, L. M. & S. Rly.	1·69	84
Hants .	Ventnor, Roy. Nat. Hos.	2·95	115	,, .	Buxton, Devon Hos....	5·56	124
,, .	Fordingbridge, Oaklnds	2·41	87	*Ches* .	Runcorn, Weston Pt...	2·43	102
,, .	Ovington Rectory.......	4·96	184	,, .	Nantwich, Dorfold Hall	2·69	...
,, .	Sherborne St. John.....	3·21	138	*Lancs* .	Manchester, Whit. Pk.	3·39	135
Berks .	Wellington College.....	1·98	100	,, .	Stonyhurst College.....	5·61	131
,, .	Newbury, Greenham...	3·28	142	,, .	Southport, Hesketh Pk	3·81	149
Herts .	Welwyn Garden City...	1·91	...	,, .	Lancaster, Strathspey	4·72	...
Bucks .	H. Wycombe, Flackwell	1·60	...	*Yorks* .	Wath-upon-Dearne.....	1·12	58
Oxf . .	Oxford, Mag. College..	1·40	81	,, .	Bradford, Lister Pk....	2·60	90
Nor .	Pitsford, Sedgebrook...	1·87	101	,, .	Oughtershaw Hall......	11·40	...
,, .	Oundle..................	·84	...	,, .	Wetherby, Ribston H.	1·64	80
Beds .	Woburn, Crawley Mill	1·44	84	,, .	Hull, Pearson Park.....	1·38	77
Cam .	Cambridge, Bot. Gdns.	·79	53	,, .	Holme-on-Spalding.....	1·29	...
Essex .	Chelmsford, County Lab	1·15	75	,, .	West Witton, Ivy Ho.	3·61	114
,, .	Lexden Hill House....	·64	...	,, .	Felixkirk, Mt. St. John	1·61	80
Suff .	Haughley House........	·86	...	,, .	Pickering, Hungate....	1·70	81
,, .	Campsea Ashe	·94	52	,, .	Scarborough.............	1·02	51
Norf .	Norwich, Eaton...... ...	·87	44	,, .	Middlesbrough...........	1·16	72
,, .	Wells, Holkham Hall	1·25	86	,, .	Baldersdale, Hury Res.	4·47	...
,, .	Swaffham, The Villa...	1·06	56	*Durh* .	Ushaw College...........	1·66	81
Wilts .	Devizes, Highclere......	2·61	120	*Nor* .	Newcastle, Town Moor	·62	30
,, .	Bishops Cannings.......	2·55	110	,, .	Bellingham, Highgreen	2·71	95
Dor .	Evershot, Melbury Ho.	5·05	145	,, .	Lilburn Tower Gdns....	1·62	78
,, .	Creech Grange..........	2·87	88	*Cumb* .	Geltsdale.................	3·53	...
,, .	Shaftesbury, Abbey Ho.	2·29	88	,, .	Carlisle, Scaleby Hall	3·64	147
Devon .	Plymouth, The Hoe...	4·43	133	,, .	Borrowdale, Seathwaite	22·74	175
,, .	Launceston, Werringt'n	6·84	171	,, .	Borrowdale, Moraine*..	22·05	...
,, .	Holne, Church Pk. Cott.	14·16	229	,, .	Keswick, High Hill.....	11·94	...
,, .	Cullompton	3·59	111	*West* .	Appleby, Castle Bank.	6·69	209
,, .	Sidmouth, Sidmount...	2·83	99	*Glam* .	Cardiff, Ely P. Stn.....	5·60	148
,, .	Filleigh, Castle Hill....	4·48	...	,, .	Treherbert, Tynywaun	18·47	...
,, .	Barnstaple, N. Dev. Ath	3·56	109	*Carm* .	Carmarthen Friary.....	...	...
,, .	Dartm'r, Cranmere Pool	15·00	...	*Pemb* .	Haverfordwest, School	7·08	153
Corn .	Redruth, Trewirgie.....	4·97	118	*Card* .	Aberystwyth............	4·52	...
,, .	Penzance, Morrab Gdn.	4·75	125	,, .	Cardigan, County Sch.	6·00	...
,, .	St. Austell, Trevarna...	4·89	114	*Brec* .	Crickhowell, Talymaes	6·50	...
Soms .	Chewton Mendip........	4·46	116	*Rad* .	BirmW.W.Tyrmynydd	9·17	154
,, .	Long Ashton.............	4·53	158	*Mont* .	Lake Vyrnwy...........	9·65	171
,, .	Street, Millfield	1·97	81	*Denb* .	Llangynhafal............	3·09	117
Glos. .	Blockley..................	2·77	...	*Mer* .	Dolgelly, Bryntirion...	8·13	143
,, .	Cirencester, Gwynfa....	3·72	148	*Carn* .	Llandudno...............	3·38	131
Here .	Ross, Birchlea..........	4·09	169	,, .	Snowdon, L. Llydaw 9	28·20	...
,, .	Ledbury, Underdown..	2·80	127	*Ang* .	Holyhead, Salt Island	4·83	166
Salop .	Church Stretton.........	4·57	181	,, .	Lligwy.....................	6·90	241
,, .	Shifnal, Hatton Grange	2·15	111	*Isle of Man*			
Worc .	Ombersley, Holt Lock	2·33	121		Douglas, Boro' Cem....	4·02	120
War .	Birminghm, Edgbaston	2·37	117	*Guernsey*			
Leics .	Thornton Reservoir....	1·26	64		St. PeterP't. GrangeRd.	2·48	85

* Previously called Borrowdale, Rosthwaite.

Rainfall: January, 1932: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per cent. of Av.
Wigt.	Pt. William, Monreith	3·07	94	Suth.	Melvich	4·71	...
,,	New Luce School	3·19	79	,,	Loch More, Achfary	14·79	203
Kirk.	Carsphairn, Shiel	12·76	174	Caith.	Wick	3·41	138
Dumf.	Dumfries, Crichton, R.I	5·24	...	Ork.	Pomona, Deerness	4·51	131
,,	Eskdalemuir Obs.	12·17	225	Shet.	Lerwick	5·46	128
Roxb.	Branxholm	5·82	212	Cork.	Caheragh Rectory	6·76	...
Selk.	Ettrick Manse	13·96	295	,,	Dunmany Rectory	8·49	136
Peeb.	West Linton	6·23	...	,,	Ballinacurra	4·76	120
Berk.	Marchmont House	2·13	95	,,	Glanmire, Lota Lo.	5·47	127
Hadd.	North Berwick Res.	1·45	84	Kerry.	Valentia Obsy	7·32	133
Midl.	Edinburgh, Roy. Obs.	2·99	172	,,	Gearahameen	14·90	...
Lan.	Auchtyfardle	6·37	...	,,	Killarney Asylum	9·24	156
Ayr.	Kilmarnock, Kay Pk.	6·95	...	,,	Darrynane Abbey	6·40	128
,,	Girvan, Pinmore	5·65	120	Wat.	Waterford, Gortmore	4·24	116
Renf.	Glasgow, Queen's Pk.	7·30	218	Tip.	Nenagh, Cas. Lough	5·15	130
,,	Greenock, Prospect H.	10·42	153	,,	Roscrea, Timoney Park	2·99	...
Bute.	Rothesay, Ardencraig.	10·07	223	,,	Cashel, Ballinamona	3·83	101
,,	Dougarie Lodge	5·57	...	Lim.	Foynes, Coolnanes	4·62	122
Arg.	Ardgour House	21·19	...	,,	Castleconnel Rec.	4·69	...
,,	Glen Etive	21·90	208	Clare.	Inagh, Mount Callan	7·00	...
,,	Oban	9·55	175	,,	Broadford, Hurdlest'n.	4·60	...
,,	Poltalloch	9·11	180	Wexf.	Gorey, Courtown Ho.	3·75	120
,,	Inveraray Castle	15·18	185	Kilk.	Kilkenny Castle	3·50	109
,,	Islay, Eallabus	6·60	141	Wic.	Rathnew, Clonmannon	3·38	...
,,	Mull, Benmore	11·60	...	Carl.	Hacketstown Rectory	3·21	90
,,	Tiree	5·65	...	Leix.	Blandsfort House	4·49	137
Kinr.	Loch Leven Sluice	3·09	98	,,	Mountmellick	4·67	...
Perth.	Loch Dhu	13·75	151	Off'ly.	Birr Castle	3·94	139
,,	Balquhidder, Stronvar	14·98	...	Kild'r.	Monasterevin	3·19	...
,,	Crieff, Strathearn Hyd.	5·86	146	Dubl.	Dublin, FitzWm. Sq.	2·15	94
,,	Blair Castle Gardens	4·43	133	,,	Balbriggan, Ardgillan.	2·07	90
Angus.	Kettins School	3·05	129	Me'th.	Beauparc, St. Cloud	2·93	...
,,	Dundee, E. Necropolis	1·81	93	,,	Kells, Headfort	3·47	110
,,	Pearsie House	3·49	...	W.M.	Moate, Coolatore	3·08	...
,,	Montrose, Sunnyside	1·32	66	,,	Mullingar, Belvedere	4·27	133
Aber.	Braemar, Bank	5·30	166	Long.	Castle Forbes Gdns.	4·47	134
,,	Logie Coldstone Sch.	2·24	93	Gal.	Ballynahinch Castle	6·88	111
,,	Aberdeen, King's Coll.	1·83	84	,,	Galway, Grammar Sch.	4·56	...
,,	Fyvie Castle	2·59	109	Mayo.	Mallaranny	8·78	...
Moray.	Gordon Castle	1·66	82	,,	Westport House	7·77	167
,,	Grantown-on-Spey	2·24	93	,,	Delphi Lodge	13·06	128
Nairn.	Nairn, Delnies	2·76	139	Sligo.	Markree Obsy	5·48	139
Invs.	Ben Alder Lodge	12·82	...	Cav'n.	Belturbet, Cloverhill	...	...
,,	Kingussie, The Birches	5·92	...	Ferm.	Enniskillen, Portora	4·37	...
,,	Loch Quoich, Loan	31·75	...	Arm.	Armagh Obsy	3·06	121
,,	Glenquoich	21·63	157	Down.	Fofanny Reservoir	6·61	...
,,	Inverness, Culduthel R.	4·29	...	,,	Seaforde	2·95	94
,,	Arisaig, Faire-na-Squir	7·60	...	,,	Donaghadee, C. Stn.	2·72	107
,,	Fort William	17·12	...	,,	Banbridge, Milltown	1·96	...
,,	Skye, Dunvegan	11·36	...	Antr.	Belfast, Cavehill Rd.	2·85	...
R & C.	Alness, Ardross Cas.	5·56	146	,,	Glenarm Castle	5·87	...
,,	Ullapool	9·09	199	,,	Ballymena, Harryville	4·32	117
,,	Torridon, Bendamph	...	...	Lon.	Londonderry, Creggan	5·06	141
,,	Achnashellach	16·97	...	Tyr.	Omagh, Edenfel	5·02	142
,,	Stornoway	6·52	...	D.n.	Malin Head	4·04	...
Suth.	Lairg	5·08	155	,,	Dunfanaghy	5·08	...
,,	Tongue	5·91	150	,,	Killybegs, Rockmount	4·64	83

Climatological Table for the British Empire, August, 1931

STATIONS	PRESSURE: Mean of Day M.S.L.	PRESSURE: Diff. from Normal	TEMPERATURE Absolute: Max.	Absolute: Min.	Mean Values: Max.	Mean Values: Min.	Mean Values: ½ max. and min.	Mean Values: Diff. from Normal	Mean: Wet Bulb	Relative Humidity	Mean Cloud Am'nt	PRECIPITATION: Am'nt	PRECIPITATION: Diff. from Normal	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F	°F.	%	0—10	in.	in.			
London, Kew Obsy.	1012·4	— 2·9	77	44	66·7	53·8	60·3	— 1·3	54·6	85	7·8	4·85	+ 2·61	16	4·4	30
Gibraltar	1015·3	— 1·4	93	61	84·0	66·1	75·1	— 0·9	64·4	79	2·4	0·00	— 0·13	0	..	..
Malta	1014·3	— 0·5	104	67	87·9	73·7	80·8	+ 1·7	72·4	71	1·5	0·00	— 0·14	0	11.8	88
St. Helena	1018·7	+ 1·9	68	53	58·8	54·4	56·6	— 0·8	54·8	97	9·8	3·82	..	21	..	..
Sierra Leone	1015·1	+ 2·4	86	66	81·2	69·5	75·3	— 2·6	75·4	91	9·0	33·67	— 2·90	30	..	..
Lagos, Nigeria	1014·0	+ 0·4	86	71	83·0	75·1	79·1	+ 1·4	74·8	84	9·3	2·10	— 0·70	16	..	..
Kaduna, Nigeria	1014·5	— 0·6	96	..	88·6	..	..	..	71·9	86	8·8	4·86	— 4·82	21	..	..
Zomba, Nyasaland	1016·1	— 0·7	85	49	77·5	55·7	66·6	+ 1·7	..	60	3·2	0·00	— 0·37	0	..	..
Salisbury, Rhodesia	1016·1	— 0·2	87	41	77·3	47·9	62·6	+ 2·4	50·1	39	0·0	0·00	— 0·06	0	10·4	90
Cape Town	1020·6	+ 0·3	84	41	64·1	48·8	56·5	+ 0·9	50·1	87	6·0	3·97	+ 0·60	18	..	..
Johannesburg	1019·1	+ 0·2	77	34	68·0	46·1	57·1	+ 2·7	42·2	32	0·6	0·00	— 0·51	0	10·5	94
Mauritius	1020·9	+ 0·4	79	57	75·4	63·0	69·2	+ 0·7	65·3	72	4·8	1·20	— 1·15	18	8·3	73
Calcutta, Alipore Obsy.	997·8	— 3·2	94	77	89·9	80·3	85·1	+ 1·9	80·8	92	8·2	8·77	— 4·61	19*	..	..
Bombay	1002·8	— 3·1	88	75	85·3	76·8	81·1	+ 0·3	77·3	88	9·1	23·71	+ 9·26	25*	..	..
Madras	1003·8	— 1·7	99	75	95·0	78·5	86·7	+ 0·7	76·5	70	6·9	3·91	— 0·63	10*	..	..
Colombo, Ceylon	1009·9	+ 0·6	86	72	84·3	76·2	80·3	— 0·9	77·2	82	8·2	9·11	+ 5·87	25	5·7	46
Singapore	1008·6	— 0·9	93	71	89·7	77·6	83·7	+ 2·1	78·4	81	7·7	5·74	— 2·21	9	7·5	61
Hongkong	1000·9	— 4·1	94	75	87·3	79·2	83·3	+ 1·2	78·9	80	7·5	14·27	— 0·37	18	6·7	52
Sandakan	..	..	93	73	90·2	75·3	82·7	+ 0·9	77·7	82	..	13·29	+ 5·40	10	..	..
Sydney, N.S.W.	1017·0	— 1·2	80	41	66·1	47·7	56·9	+ 1·9	49·6	68	3·2	0·32	— 2·65	6	7·8	72
Melbourne	1016·2	— 1·8	64	36	57·6	44·1	50·9	— 0·1	47·2	80	7·6	1·87	0·00	19	4·0	37
Adelaide	1017·9	— 1·4	67	42	60·6	46·4	53·5	— 0·4	48·9	72	5·9	2·55	+ 0·02	20	5·0	46
Perth, W. Australia	1017·7	— 1·2	71	38	63·7	48·3	56·0	0·0	51·2	70	6·8	6·84	+ 1·19	19	4·9	45
Coolgardie	1019·1	— 0·2	76	34	63·9	43·0	53·5	— 0·1	47·5	63	3·2	1·57	+ 0·58	7	..	..
Brisbane	1019·0	— 0·2	79	43	72·2	51·3	61·7	+ 1·3	54·9	69	4·7	0·90	— 1·18	7	7·5	67
Hobart, Tasmania	1009·2	— 4·2	63	34	54·3	41·6	47·9	— 0·1	43·1	69	6·6	1·19	— 0·64	19	5·0	48
Wellington, N.Z.	1012·9	— 2·2	57	32	51·0	41·4	46·2	— 2·4	44·5	81	7·4	2·23	— 2·26	18	4·3	41
Suva, Fiji	1013·6	— 0·6	88	62	79·0	69·8	74·4	+ 0·8	69·7	77	6·5	6·16	— 2·13	14	4·3	37
Apia, Samoa	1011·2	— 1·1	87	69	84·3	74·0	79·1	+ 1·3	75·8	77	5·7	2·00	— 1·63	10	7·1	61
Kingston, Jamaica	1013·7	+ 0·2	94	73	90·3	74·6	82·5	+ 1·0	73·1	80	3·3	1·83	— 1·72	5	7·8	61
Grenada, W.I.	1013·5	+ 0·9	90	73	88·3	74·8	81·5	+ 1·8	75·2	77	4·7	9·17	— 0·16	26	..	..
Toronto	1016·3	+ 0·9	92	46	78·4	60·5	69·5	+ 2·3	61·8	72	4·2	2·10	— 0·69	11	7·9	56
Winnipeg	1014·4	+ 1·2	100	36	78·2	55·5	66·9	+ 3·1	55·3	68	4·3	2·02	— 0·14	8	8·7	60
St. John, N.B.	1015·9	+ 0·6	79	49	72·1	55·6	63·9	— 3·3	59·8	83	5·4	4·04	+ 0·18	13	7·7	55
Victoria, B.C.	1018·6	+ 1·7	84	50	68·0	52·1	60·1	+ 0·4	55·8	83	2·7	0·20	— 0·44	4	11·3	79

*For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

Victoria, B.C.	1018·6	+ 1·7	84	50	68·0	52·1	60·1	+ 0·4	55·8	83	2·7	0·20	—	0·44	4	11·3	79